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Sustainable Digital Finance: The Role of FinTech, InsurTech Blockchain for Shaping the World for the Better

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Abstract: The digital finance revolution, which is often termed the “FinTech Revolution”, is currently changing the financial services industry through innovative solutions, often developed by startup and Big Tech companies. The financial sector is one of the key pillars of all economic transactions in general and sustainability specifically. As is so often the case: money is power. Innovative examples range from digital supply chain finance enabled agricultural and fashion value chains bridging Western and African as well as Asian countries, digital currency fueled smart meters for schools in Africa, digital investment marketplaces for forest tokens to crowdfunding enabled entrepreneurship in Asia and South America. Digital innovation in financial services is changing the way how financial resources can be accessed, distributed, and managed. This paper analyzes approaches from the emerging field of FinTech, InsurTech and blockchain at the intersection of sustainability. By reading through almost one-hundred and fifty papers from academia and practice as well as analyzing hundreds of start-ups in this field, the major building blocks were derived and a future research and innovation agenda was developed. The Appendix which is mentioned in this paper is downloadable online: www.sustainable-digital-finance.org. The results indicate that the topic is of great emerging interest. The areas of the focus are energy management, financial services, governments/NGOs, and transportation as well as some other relevant sectors that hold great potential and in which the combination of business and sustainability benefits is more obvious than ever enabled through innovative technology. The analysis reveals that future research and innovation areas might be fruitful in (1) novel ways for an integrated measuring of business and sustainability benefits, (2) novel sustainable cross-industry ecosystems and business models relying on new FinTech, InsurTech and blockchain enabled products and services, (3) new forms of organizational designs such as autonomous distributed organizations and processes built on new governance mechanisms and (4) novel FinTech, InsurTech, and blockchain applications for Sustainable Digital Finance Ecosystems.

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Sustainable Digital Finance

The Role of FinTech, InsurTech & Blockchain
for Shaping the World for the Better



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June 2020

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Executive Summary

The digital finance revolution, which is often termed the “FinTech Revolution”, is currently changing the financial services industry through innovative solutions, often developed by start-up and Big Tech companies. The financial sector is one of the key pillars of all economic transactions in general and sustainability specifically. As is so often the case: money is power. Innovative examples range from digital supply chain finance enabled agricultural and fashion value chains bridging Western and African as well as Asian countries, digital currency fueled smart meters for schools in Africa, digital investment marketplaces for forest tokens to crowdfunding enabled entrepreneurship in Asia and South America. Digital innovation in financial services is changing the way how financial resources can be accessed, distributed, and managed.

This paper analyzes approaches from the emerging field of FinTech, InsurTech and blockchain at the intersection of sustainability. By reading through almost one-hundred and fifty papers from academia and practice as well as analyzing hundreds of start-ups in this field, the major building blocks were derived and a future research and innovation agenda was developed. The Appendix which is mentioned in this paper is downloadable online: www.sustainable-digital-finance.org. The results indicate that the topic is of great emerging interest. The areas of the focus are energy management, financial services, governments/NGOs, and transportation as well as some other relevant sectors that hold great potential and in which the combination of business and sustainability benefits is more obvious than ever enabled through innovative technology. The analysis reveals that future research and innovation areas might be fruitful in (1) novel ways for an integrated measuring of business and sustainability benefits, (2) novel sustainable cross-industry ecosystems and business models relying on new FinTech, InsurTech and blockchain enabled products and services, (3) new forms of organizational designs such as autonomous distributed organizations and processes built on new governance mechanisms and (4) novel FinTech, InsurTech, and blockchain applications for Sustainable Digital Finance Ecosystems.

For research and innovation organization, this paper suggests a novel innovation platform encompassing all relevant stakeholders to jointly engage in the creation of solutions to shape the world for the better. Technology-induced innovation has always been an enormous source for mankind to shape the future. The new platform for Sustainable Digital Finance aims to bridge the innovation value chain from academic research to solutions. We think that an innovation ecosystem consisting of academia, start-ups, and incumbents as well as public and non-governmental organizations which focuses on the connection of these stakeholders and the “creation” of novel innovations provides a beneficial approach for all of them.

1. Sustainability, Digitalization and Finance

The financial services industry, which includes banks and insurance companies, is currently facing a situation like the music-, office machines-, or entertainment industry some decades ago: Big Tech companies like Amazon, Apple, Facebook, Google, and Microsoft have redefined various industries such as entertainment, IT, food, fashion, etc. Transferred to the financial services sector, this analogy means that digitalization not only improves existing business processes, but it enables entirely new business models and might radically change the entire industry. The terms “FinTech” and “InsurTech” address such innovative concepts at the intersection of finance, insurance, and technology and encompass innovative financial solutions enabled by IT and, in addition, are often used for start-up companies who deliver those solutions, although they also include the incumbent financial services providers such as banks and insurers. Among the examples are novel, token-based financing platforms for start-ups in developing countries who do have only limited access to bank credits in their countries, new payment infrastructures based on digital vouchers, currencies, digital wallets for improving waste management in smart cities, peer-to-peer trading platforms for renewable energy production and consumption, and autonomous decentralized organizations based on blockchain for the governance of financing large (public) projects to prevent fraud and corruption. In recent years, many start-ups emerged at the intersection of digital finance and sustainability covering areas such as blockchain solutions for sustainable supply chains, etc. (Nassiry, 2018).

The financial sector provides the “glue” for all economic activities. Just like logistics firms who are key connectors of physical goods value chains, financial services firms act as enablers and risk takers of all economic transactions of physical goods and service markets. The financial sector is a crucial element for providing payments infrastructures, directing financial capital to economic activities, offering investment opportunities in companies, and (re-) insuring economic activities. With this, it holds a key role in implementing sustainable economies for the future: (1) The finance sector acts as an investor in companies which operate in areas that have a high impact on sustainability. An example is the Task Force on Climate-Related Financial Disclosures (TCFD) from the Financial Stability Board which aims at reducing investments at banks and insurers in carbon-related companies. (2) The second role is as an investor in novel (FinTech, InsurTech and blockchain) start-ups and initiatives which are predicted to require at least \$5-\$7 trillion per year in sustainability investments comprising infrastructure, food security, climate change mitigation, and adaption as well as health and education ((OECD, 2017), (Nassiry, 2018)). Finally, a third role is the one of a risk taker (Economist, 2019). For example, the annual insured losses from catastrophic events have globally grown twenty times from the 1970s to approx. \$65 billion in the 2010s with an even higher number in 2019 totaling at \$85 billion. In addition, the global gap between total insured losses and uninsured losses (so-called protection gap) double from 2000 to 2018 to \$1.2 trillion. Approximately half of all global disasters in 2018 were uninsured. These increasing numbers show that sustainability has a direct impact on financial services and vice versa (see Figure 1).

Sustainability is one of the so-called “Grand Challenges”. The United Nations’ definition of the seventeen sustainable development goals (SDGs) combines the most pressing of these Grand Challenges, such as poverty, inequality, climate change, environmental degradation, and prosperity, into a single framework (www.un.org/development/desa/disabilities/envision2030.html). Grand Challenges are more than general research questions, they focus on topics and results that are global in scale, and are very difficult to accomplish, yet offer hope of being ultimately tractable; demand an extensive number of research projects across many technical and non-technical disciplines. They can be defined as “specific critical barrier(s) that, if removed, would help solve an important societal problem

with a high likelihood of global impact through widespread implementation” (George et al., 2016, 1881). Because one core principle of Grand Challenges is their interdisciplinary nature, this paper connects the three fields of sustainability, finance and technology which have been, until now, mostly separate fields of research and innovation (see Figure 1). The remainder of this paper is structured in four sections. Section 2 identifies the state of the art of academic research (theory) and start-ups in this field (practice). Section 3 discusses potential fields for future research and innovation. Finally, section 4 proposes a new platform for Sustainable Digital Finance Innovation.

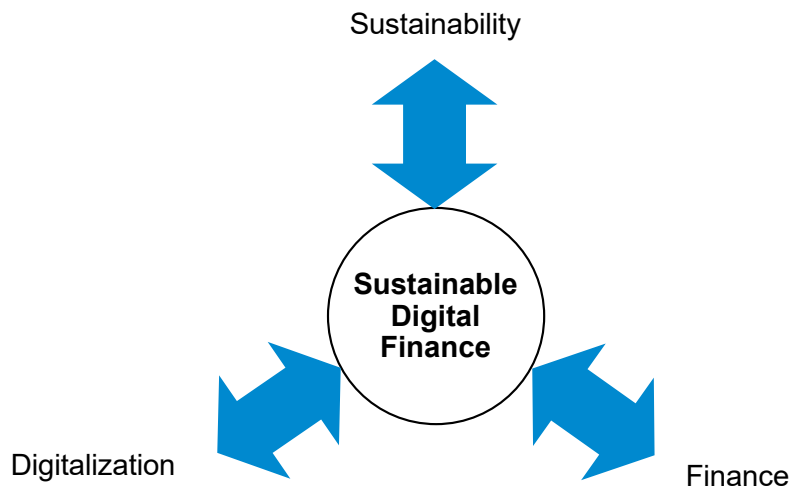


Figure 1. The Interdisciplinary Nature of Sustainable Digital Finance

2. Theoretical Background

In order to analyze existing approaches in more detail, an inductive method was chosen. This approach allows not only the identification of the state of the art, but also the definition of future areas of research based on today’s knowledge. For this, guidelines from Grounded Theory¹ were used for the analysis of literature from academia and practice as well as relevant start-ups in this field (see Appendix 1).

¹ Grounded theory is a systematic methodology which is based on inductive reasoning (instead of deductive modeling) (see (Strauss and Corbin, 1994)). Grounded theory is suitable for developing novel concepts and theories where existing research is rare. It often begins with the collection of (qualitative) data. By reviewing the data, basic elements become apparent and are tagged with codes, which are extracted from the data. Based on these codes, the data can be grouped into concepts and categories. These categories may later become the basis for new theory as additional knowledge is created.

2.1 Findings from Existing Research

From the analysis of the academic research papers, the approaches from practice as well as the analysis of start-ups in that field, a framework could be developed which summarizes the existing knowledge on the topic and provides building blocks for future research (see Figure 2, Appendices 2 and 3). It describes the relevant categories and relationships among the building blocks. These building blocks consist of (1) drivers which trigger change, (2) ecosystems which show the areas of future change with regard to strategic, organizational as well as system related aspects and (3) business and sustainability benefits. All building blocks are described in more detail in the following.

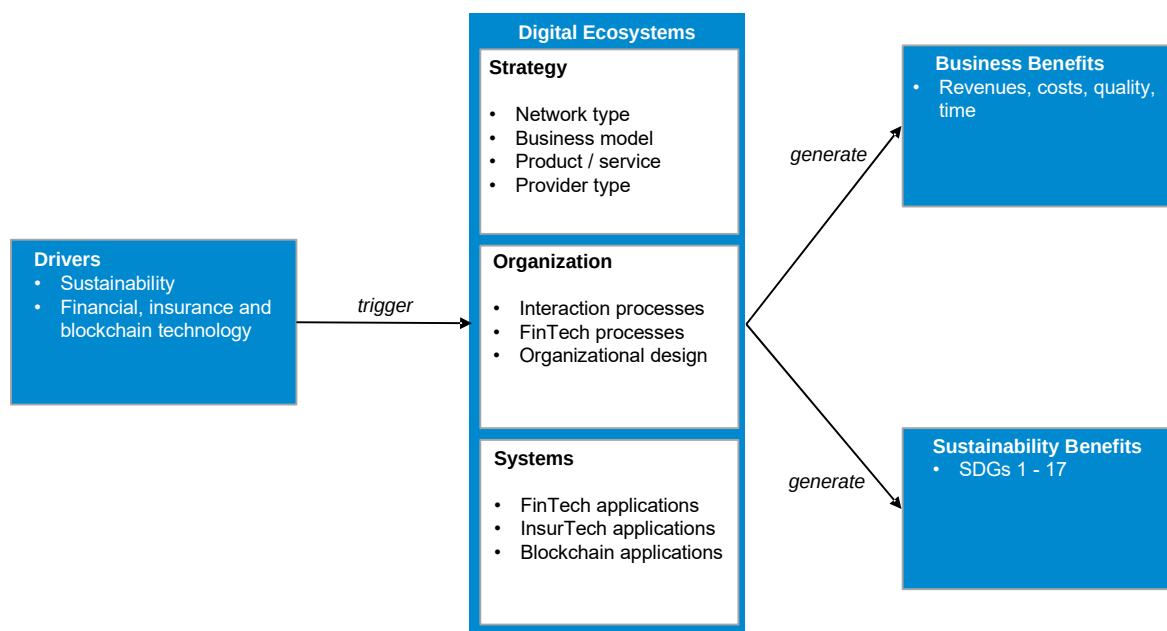


Figure 2. Building Blocks of Sustainable Digital Finance

Drivers

Financial technology (FinTech) is a term which emerged as a contraction of “financial technology”. It is based on three areas ((Puschmann, 2017), (Gomber et al., 2018)). These are the evolution of novel technologies such as blockchain or artificial intelligence, the convergence of these different technologies and the enabling effect of them on new application areas and business models. In addition to FinTech, InsurTech is often used as a separate term which describes insurance related technological innovations, such as micro insurances or on demand insurances delivered via mobile apps or online channels. In the context of FinTech and InsurTech, blockchain is one of the major core technologies of FinTech and InsurTech (others are Artificial Intelligence, Big Data, Cloud Computing, etc.). All terms address innovative concepts at the intersection of finance and technology and are often used interchangeably. Because FinTech, InsurTech and blockchain solutions are closely connected with

“financial innovations”, they generally differ regarding the innovation objects (strategic aspects: network type, business model, products and services, provider type; process and organizational aspects: interaction processes, FinTech-/InsurTech processes, organizational design, and system aspects: FinTech-/InsurTech/blockchain applications), the innovation scope (intra- or inter-organizational) and the innovation degree (incremental or disruptive) ((Puschmann, 2017), Gomber et al., 2018)).

While FinTech enables change from a technical perspective, sustainability is most commonly defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987). The etymology of the term originates in the French verb “soutenir” which means “to hold up or support.” Sustainability has a very long-term focus covering the three areas of economic prosperity, environmental protection, and social equity (Elkington, 2013). The idea that a business activity can simultaneously result in financial, social, and environmental benefits is very much in line with recent developments in sustainability and related concepts such as the circular economy ((Bocken et al., 2014), (Geissdoerfer et al., 2017)). In recent years the concept of sustainability has been connected to the field of “innovation”. According to Arena et al. (2018) “sustainable innovations” are defined by a blended-value mission entailing the coexistence of impact objectives (e.g., increasing the flow of financial resources for sustainable development) and business objectives (e.g., safeguarding a financial return to be able to continue creating an impact long-term).

Both concepts, FinTech, InsurTech, blockchain, and sustainability are drivers of the transformation. Examples are blockchain based supply chains for tracking product movements from farmers to retailers throughout the agriculture supply chain which not only gives the farmers easier access to financing instruments and provides the wholesalers and consumers with real-time tracking (business benefits), but also holds various sustainability benefits such as transparency of origins of products, concerns over modern slavery, and how to extend sustainable practices and governance up-stream in supply chains. Another example is the blockchain enabled transformation of energy management through decentralized p2p platforms for the production and consumption of energy by the use of digital currencies and digital wallets as well as smart contract enabled payments, investments, and financing approaches. As green-house gas emissions are linked to 70-85% of energy production, such an approach holds great potential.

Ecosystems

The analysis in this paper revealed that sustainability is often discussed with regard to so-called “ecosystems” in which various economic stakeholders collaborate.² An example is a blockchain-based sustainable supply chain for agricultural products in which farmers, manufacturers, wholesalers, retailers, and consumers are digitally connected for information and financial processes (Kamble et al., 2020). Another example is energy ecosystems which connect various stakeholders for sustainable energy production, distribution and consumption ((Li et al., 2019), (Zhu et al., 2020), (Wu and Tran, 2018)). In general, a “Business Ecosystem” is defined as an “economic community supported by a foundation of interacting organizations and individuals - the organisms of the business world. The economic community produces goods and services of value to customers, who themselves are members of the ecosystem (so-called “prosumers”). The member organisms also include suppliers, lead producers, competitors, and other stakeholders. Over time, they co-evolve their capabilities and roles and tend to align themselves with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of the ecosystem leader is valued by the community as it enables members to move toward shared visions of aligning their

2 See Appendix 2 for a more detailed view on the existing literature.

investments and finding mutually supportive roles.” (Moore, 1996, 26). Ecosystems provide design options regarding strategic (network type, business model, product/service, provider type), organization (interaction processes, FinTech processes, organizational design) and system related (FinTech applications, InsurTech applications, blockchain applications) aspects ((Weill & Woerner, 2015), (Jacobides et al., 2018)).

The findings of the analysis in this paper indicate that research on the topic of Sustainable Digital Finance is still rare and only 29 relevant research papers could be identified. In contrast to that, the search terms “FinTech”, “InsurTech” and “blockchain” deliver 60’300, 2’270 and 236’000 results on Google Scholar. Most research with regard to Sustainable Digital Finance has been undertaken in the area of energy and financial services followed by government/NGO agriculture and waste management. Other fewer research stems from transportation, manufacturing, mining, building, healthcare, and fashion. A small number of research provides generic models on supply chain management (see Figure 3; see Appendix 2 for more details). But as almost all concepts and approaches from academia and practice that could be identified in this paper are from the past few years (mainly from 2018 – 2020), more research and innovation is required in all sectors. For example, in Switzerland an initiative is currently being established to standardize protocols for all energy related processes based on blockchain called “DLT for Power”. In the future new business models will be required which are built upon these new technical layers. In other sectors, such as financial services, the standardization of criteria for sustainable investments are still in their infancy. Others like agriculture, waste management and transportation haven’t even started yet. The potential for innovation is enormous.

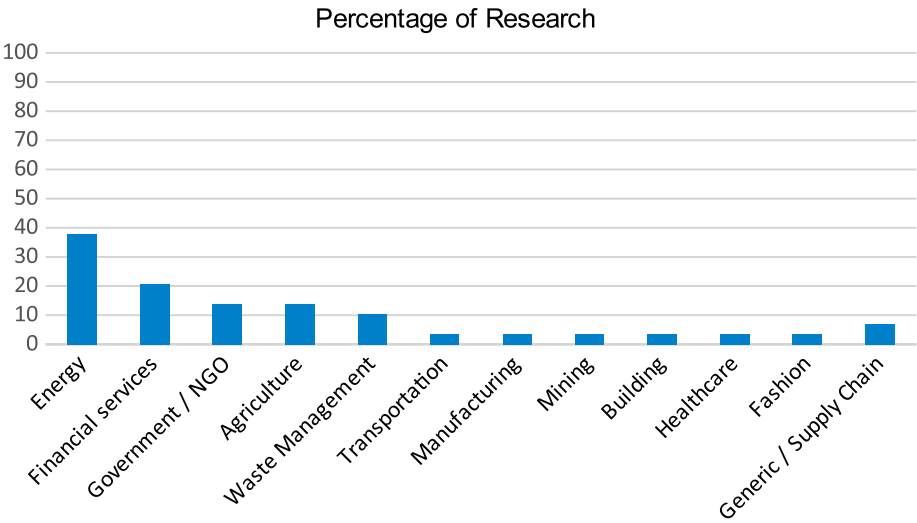


Figure 3. Industry Focus (N=29)

Compared to their business models, existing research primarily focuses on operational excellence. This is in line with many blockchain oriented models that specifically target operation efficiency as their main goal, while only a few aim at customer intimacy or product leadership (see Table 1). Importantly, some of the approaches contain more than one business model and process. The analysis clearly shows that the improvement of business processes (operational excellence) is one of the main goals, while new products and novel ways of customer interaction still are in a very early phase of development. In addition, first approaches concentrate on payments infrastructures (e.g., digital currencies and digital wallets) while other forms of investments, financing, and insurance are still rare.

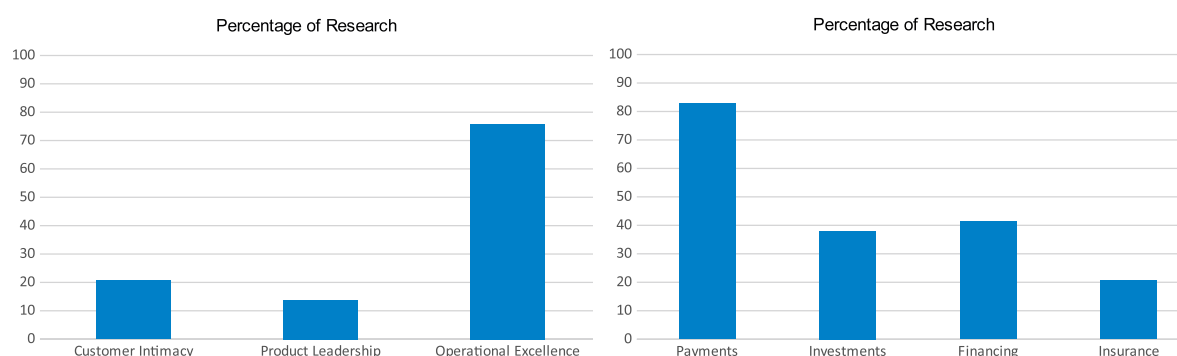


Table 1. Business Models and Processes (N=29)

FinTech and blockchain applications are at the core of the technology domain. In most cases, FinTech and blockchain applications are mixed. InsurTech is still in its infancy. The analysis clearly demonstrates that digital finance applications are the “glue” element for novel sustainable business models. One example is the energy sector where innovation remains very rare. For example, for investors, it is still almost impossible to support decentralized renewable energy generation in other countries. On the other side, the access to capital provides a great barrier for renewable energy producers in many countries, particularly the developing ones, especially as power production today is mainly based on centralized power grids where very often the vast majority of society is not being connected to such grids. In this case FinTech and blockchain applications could solve this issue by energy tokens which are stored on blockchains, and which are directly linked to the production of renewable energy. This offers a huge opportunity for change as for the first time (p2p) payments of renewable energy (e.g., via an energy coin) as well as investments and financing in such solutions would be possible on a global scale. Combined with novel ways of decentralized organization (see Table 2), this approach provides a powerful instrument.

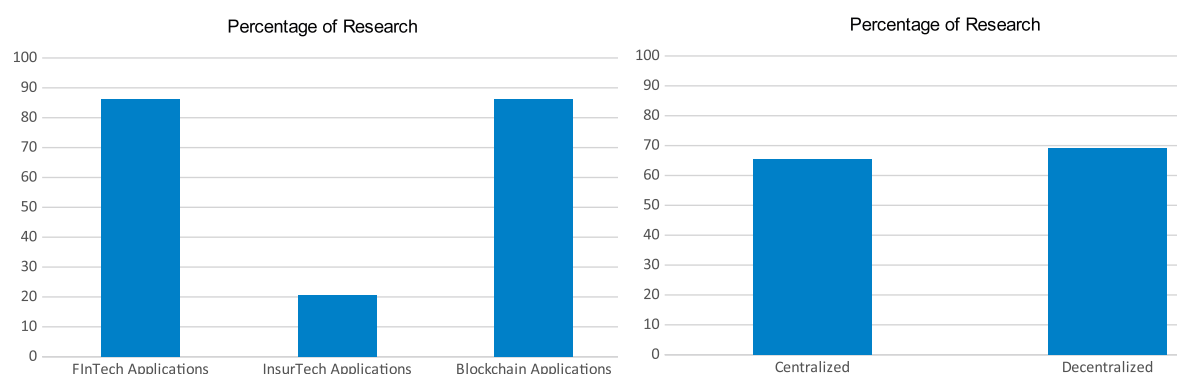


Table 2. Organizational Design and Applications (N=29)

Business and Sustainability Benefits

A third field of results relates to the benefits which the analyzed literature documented as relevant. In general literature differentiates business and sustainability benefits which are in some cases inter-related. From the business perspective the benefit categories revenues, costs, quality and time can be distinguished (see Appendix 2). From the sustainability perspective, the seventeen sustainability goals from the United Nations (<https://www.un.org/development/desa/disabilities/envision2030.html>) were used to map the identified benefits to sustainability considerations. The analysis shows

that the main focus is on the sustainability goals 7 to 13 and 17. The clear leader is the sustainability goal no. 9 which aims at developing a resilient infrastructure, the promotion of inclusive and sustainable industrialization and innovation (e.g., for online forest credit platforms (Tavares, 2019)).

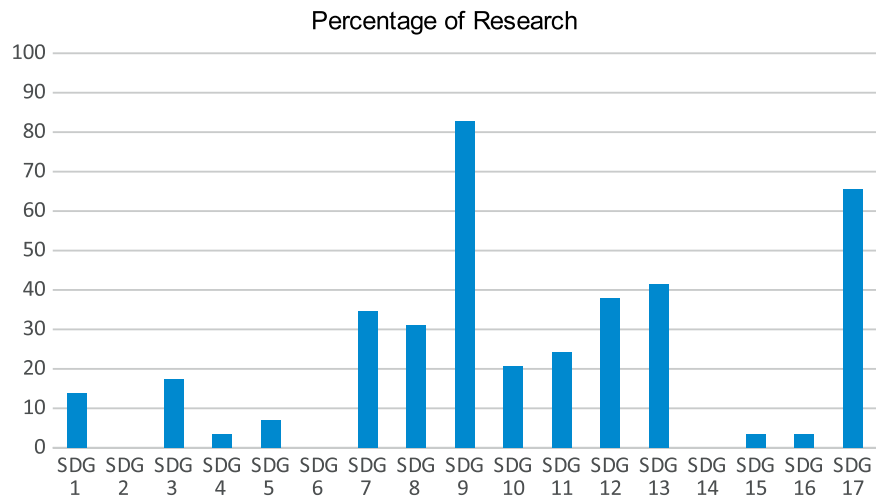


Figure 4. Sustainability Benefits (N=29)

2.2 Findings from the Start-up Analysis

Similar as the academic literature, the start-ups in this field are also either driven by technology and/or sustainability (Climate-KIC, 2019). For example, the Energy Web Foundation approaches the topic from the sustainability side, while Consensys does from the blockchain side. In the past few years, several studies have been conducted on the impact and potentials of FinTech, InsurTech and blockchain on sustainability (e.g., (Climate-KIC, 2019), (Green Digital Finance, 2018), (IRIFC, 2019), (OECD, 2019), (SEMARNAT, 2019), (Task Force on Digital Financing, 2019), (UN Environment, 2019), (WEF, 2018)). These studies come to similar conclusions as the review of the academic literature in the previous section: (1) The number of start-ups in this field is still very low. For example in Switzerland, there are only 24 start-ups in the field of Sustainable Digital Finance, while the total number of FinTech, InsurTech and blockchain start-ups is more than 350. (2) Most activities are centered around energy financial services as well as governments/NGOs (see Figure 3). (3) FinTech InsurTech and blockchain are the most relevant applications in this field and (4) the major sustainability goals which are currently supported by the start-up ecosystem are the sustainability goal 9 (industry, innovation & infrastructure) 7 (affordable and clean energy) and goal 13 (climate action) combined with goal 17 (partnership for the goals). Summarized the start-up ecosystem provides the following insights:

- **Financial services:** The financial services sector is closely linked with other economic activities (see section 1) and provides the “glue” for relationships among stakeholders in digital ecosystems. One application area is impact assessment, for which the ixo protocol is a good example. ixo assumes that proven impact data is a valuable asset for all those interested in funding sustainability oriented activities. The impact of a given project is ideally automatically measured by sensors, or where this is not possible verified by some intermediaries. Another example for measuring the impact are yourSRI.com or Covalence who provide tools for evaluating companies with regard to sustainability criteria. A second area are financing solutions for sustainability projects of all kinds, such as solar projects in developing countries,

etc. An example is the Ground-Up project which brings together start-ups and investors or Carbon To Clean, an investment community dedicated to renewable energy investing and sustainable energy solutions. Wild Finance is a sustainability fintech startup, which provides a card that rewards consumers with cash back and matches their reward with a donation to partner nonprofits. A third area are risk management solutions such as the evaluation of sustainability risks. Carbon Delta, for example, identifies climate related risks and measures the future impact on business models of firms and their supply chains.

- **Energy:** Another important sector is the energy industry as this industry is responsible for more than 70% of greenhouse gas emissions globally. One analysis, for example, identifies 144 start-ups in this field alone (Climate-KIC, 2019, 51). By decentralizing (energy production and storage), democratizing (peer-to-peer instead of business-to-consumer) and digitalizing (e.g., automating processes, such as payments and financing of renewable energy sources, etc.) energy management could significantly be improved. Among the examples are the platform Share&Charge for electric vehicle charging or WePower, a marketplace which connects companies directly with producers of green energy as well as Power Ledger, an energy trading platform that allows selling and buying renewable energy. A second field is emissions trading, for which blockchains hold promising potentials. Today, this market is mainly focused on big industrial emitters of carbon pollution due to high transaction costs. Blockchain could reduce these transaction costs and, by combining blockchain with IoT, automating the analysis of pollution levels. As most companies globally belong to the SME segment, the expansion to smaller companies would increase the reach of carbon trading. Examples for start-ups in this area are CarbonX, Climatecoin, Veridium, and Earth Token.
- **Government/NGO:** A third sector is the one of governments and NGOs. One very important area is impact entrepreneurship and investing. In many countries the achievement of sustainability goals is currently being connected with entrepreneurship. For example, the Swiss Entrepreneurship Program focuses on supporting innovation ecosystems in other countries rather than providing money for self-development activities. But still, often sustainability projects often do not correlate with public funding schemes. Blockchain based solutions can leverage sustainability-oriented innovation by providing novel ways of financing and investing through digital assets on blockchains (e.g., in China SMEs account for 70% of the GDP but have access to only 20% of bank loans). Among the examples in this area are DAO IPCI, Planet N Group and Envest, a global microfinance fund that offers impact investment opportunity for investors. A second field are common/public goods. Sustainable Digital Finance may contribute to this by incentivizing individuals or organizations for a certain behavior. These may be areas such as energy reduction, preservation of biodiversity, etc. Examples in this area are SolarCoin, Electric Chain or Sun Exchange. A third area is financial inclusion. A very important development in this area are digital IDs which provide the entry point to financial services and other fields for many individuals such as land registries (e.g., Bitland's blockchain-based land registry in Ghana where more than 70% of the land is unregistered today). Based on this, other services such as (digital) cash transfers to the underbanked can be provided more efficient, transparent and secure, through digital vouchers and wallets which allow people to purchase their food, medicines, etc. with their mobile phones, make lower cost remittances (e.g., Ripple), or can purchase insurance policies (e.g., Saldo.mx in Mexico). A fourth area is corruption and fraud prevention. Digital IDs are an essential requirement for this. Know-Your-Customer solutions enhance them by allowing providers of digital services to onboard their clients electronically. An example is the start-up Tradle. A fifth and final field of future development are decentralized digital governance mechanisms. An example is Estland's approach to allow a digital citizenship. Others are supranational governance mechanisms enabled by smart contract based blockchains.

- **Transportation:** A fourth sector is transportation. A first field for future development by Sustainable Digital Finance are peer-to-peer mobility platforms. This includes electric cars and the use of low-carbon public transportation system such as shared/peer-to-peer mobility systems. The OECD assume that such platforms could reduce greenhouse emissions by up to 40%. In such platforms, blockchains based on smart contracts can automate payments, financing and insurance and thus can be digitally connected to the financial system. A second area in this field is supply chain management. Global supply chains are often complex and opaque and lack provenance, traceability and transparency of data due to data silos distributed across various stakeholders. This affects all actors. From a consumer perspective, this means to have a clear view on how their consumption habits and purchasing decisions are affecting the environment, the working and living conditions, etc. along a certain supply chain. From a business perspective, firms have to report sustainability criteria to investors and governments which is only possible if supply chains and the products become more transparent. Blockchain for example has the potential to connect all stakeholders in a global supply chain (workers in factories, logistics companies, retailers, consumers, investors, NGOs, regulators) over one platform. This platform provides all relevant (provenance) data, traceability, transparency and governance mechanisms. Among the examples are ixo Blockchain for Impact, BNDES Token, TruBudget and the #REDD-Chain Project.

Appendix 3 provides an overview of selected start-ups in the field of Sustainable Digital Finance.

An integrated perspective of digital ecosystems and sustainability can be achieved by aligning the seventeen SDGs (People: 1-5; Planet: 6-7 and 13-15; Prosperity: 8-9 and 12; Peace: 10-11 and 16; Partnership: 17)³ with the three layers of digital ecosystems (strategy, organization, systems, see Figure 5). Both axes, the vertical one with strategy, organization and systems as well as the horizontal five groups of the SDGs are interrelated. This means for example that strategic considerations have an impact on organizational and system related aspects and partnership related topics may also have an impact on peace and prosperity. But the two axes also have to be aligned to each other as digital financial ecosystems lead to sustainability innovations in one or several of the five groups.

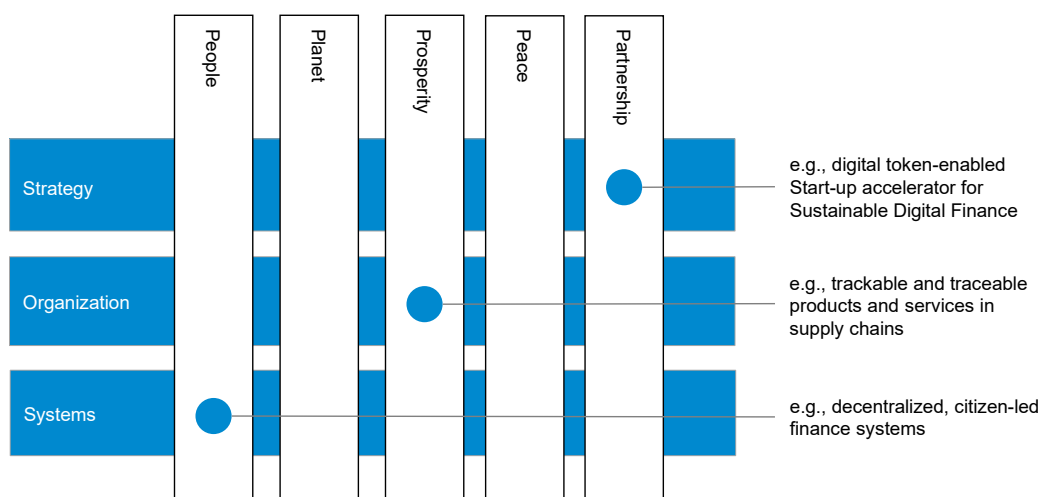


Figure 5. Relevant Fields for Sustainable Digital Financial Ecosystems Innovations

³ See <https://corpgov.law.harvard.edu/2018/10/04/un-sustainable-development-goals-the-leading-esg-framework-for-large-companies-for-the-grouping-of-the-sdgs-into-these-five-categories>.

3. Fields of Future Research and Innovation

Although sustainability is a grand challenge and requires innovations in various fields, the combination towards sustainable digital finance innovations is still premature. The analysis in this paper reveals four areas of future research which are derived from the analysis in section 2 and aligned with the four areas from the developed framework. These research and innovation fields are (1) benefit related areas as well as the ones that are related to (2) strategy, (3) organization, and (4) systems of future Sustainable Digital Finance ecosystems.

(1) Research and Innovation on Business and Sustainability Benefits in Sustainable Digital Finance

Although technology and sustainability are the primary drivers of change towards a more sustainable economy, the impact question is still in its infancy. Especially as there is often a conflict between sustainable and economic benefits, both fields have to be combined entailing the coexistence of impact objectives (e.g., increasing the flow of financial resources for sustainable development) and business objectives (e.g., safeguarding a financial return to be able to continue creating impact on a long term) (Arena et al., 2018). An integrated framework for measuring sustainability and business benefits must therefore be one of the top priorities (Economist, 2020). For example, a recent analysis revealed that sustainability principles are not yet integrated in today's rating agencies' principles (Escrig-Olmedo et al., 2019). This still is a major obstacle to directing investments into sustainable innovations. Another example is the fashion industry, which employs more than 60 million people globally and is worth more than US\$2.5 trillion. It is characterized by producing lots of pollutants and selling products in markets full of demand uncertainty. For pollutant control governments have imposed different environment taxes on the fashion industry with a goal of enhancing environmental sustainability. For market uncertainty, traditionally, fashion companies employ market demand data to improve demand forecasting. In emerging markets such as South Africa, India, and China, however, it is commonly known that data quality is often poor. With a blockchain based solution that can systematically store data and make it visible to all relevant parties information sharing, financial processes, and supply chain transparency, can be improved and lead to combined business and sustainability benefits.

Research and
Innovation
Field 1

(1.1) Novel ways for Measuring Business and Sustainability Benefits:

Integrated framework for measuring business and sustainable benefits

(2) Research and Innovation for Strategies in Sustainable Digital Finance

As the topic of Sustainable Digital Finance is just emerging, the analysis of the state of the art in section 2 revealed that the approaches today primarily concentrate on the energy (e.g., peer-to-peer renewable energy-trading systems), the financial services (e.g., digital currency-enabled smart meters for water and energy supply), the government/NGO (e.g., financial inclusion, corruption prevention, etc.), agriculture (e.g., supply chain finance for farming products), and waste management (e.g., digital currency incentivized waste management) sectors. This is in line with the analysis of the start-ups in this field, where these sectors also dominate. But as lines between industry sectors become blurred and are more and more interlinked by digitalized cross-industry

ecosystems (McKinsey & Company, 2019) a clear distinction between individual industries and companies will not be possible in the future. Examples are the Big Tech companies Google, Apple, Facebook, and Amazon (GAFA) as well as their Chinese counterparts Baidu, Alibaba, and Tencent (BAT) which offer services in all kinds of industries ranging from IT, and retail to finance.

The core question for cross-industry ecosystems will be how FinTech, InsurTech, and blockchain related sustainability concepts can be implemented in these novel digital ecosystems. What will future business models look like if sustainability concepts are applied (e.g., business models for the circular economy)? How can supply chains with FinTech, InsurTech, and blockchain concepts be designed to become sustainable? One can also observe that a (radical) business model innovation might become more important than an incremental business (process) innovation. Another relevant question in this context is the integration of governments and regulatory supervision into these ecosystems (e.g., in the context of energy or waste management where governmental authorities are involved). Today's innovations in the sustainability field are often driven by governments/NGOs and start-ups are very often not or only partly involved.

A second field for future research and innovation in the strategic domain are novel products and services. If sustainability concepts based on FinTech, InsurTech, and blockchain are implemented across industries into innovative business models, what is the impact on products and services? Clearly, transparency is one of the core drivers across supply chains (e.g., tracking and tracing, provenance) and across product categories. This can only be achieved if products can be evaluated regarding their social, environmental, and economic input and output resources (e.g., product and service taxonomies). A very important field is digital assets (these can be all kinds of resources) on blockchains which allow firms to implement transparency, provenance, and traceability. Only if products and services are transparently trackable, trust can be built that the products' "ingredients" contain what the providers claim that they contain.

<p>Research and Innovation Field 2</p>	<p>(2.1) Novel Networks: Sustainable cross-industry ecosystems and business models</p> <p>(2.2) Novel Products and Services: Novel digital products and services for sustainable digital finance ecosystems</p>
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(3) Research and Innovation for organizational Topics in Sustainable Digital Finance

Strategic and technology driven changes are inducing major changes also on an organizational level. One core area of the transformation is the concept of autonomous distributed organizations for sustainable digital ecosystems. While hierarchies are mostly not applicable in networked organizations, more autonomous forms of organizations are required. An example is adapted regulations for blockchain enabled smart contracts (e.g., accountability of certain eventual failing activities), the emergence of new institutions (e.g., auditors for digital sustainability supply chains or digital notaries for automated contracting) as well as entirely new governance mechanisms which support these new institutions.

An important driver with respect to this is "tokenization" which shows novel ways how sustainable investments (e.g., energy and transportation systems) can be developed by distributed, tokenized funding. This improves more decentralized, citizen-led finance systems and creates new infrastructure where needed. For example, if every person on this planet contributed \$896

annually, the annual required investment of \$6.9 trillion for the development of a climate-neutral infrastructure could be easily raised (UN Environment, 2019). But today, the societal, ecological, physical, and financial infrastructure is in many ways (digitally) decoupled from each other and thus, synergies cannot be leveraged. The examples range from consumers which are able to produce and sell their own energy via standardized digital currencies and blockchains to climate-resilient agricultural supply chains where start-ups such as Bushel24 is enabling payment processes in the supply chain for applications such as grain storage and in Australia CropLogic25 provides farmers with a scientific crop growth forecasting solution for yield optimization.

Research and Innovation Field 3	<p>(3.1) Novel Organizational Designs: Autonomous distributed organizations and processes for sustainable digital finance ecosystems</p> <p>(3.2) Novel Governance Mechanisms: Governance, regulation and auditing models for sustainable digital finance ecosystems</p>
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(4) Research and Innovation in Systems related fields of Sustainable Digital Finance

A fourth field of research and innovation lies in FinTech, InsurTech and blockchain applications and the integration of them along Sustainable Digital Finance ecosystems. As the internet currently develops towards the “Internet of Value”, a broad variety of new protocols, applications and integration middleware evolves. Among the most important areas are novel FinTech and InsurTech applications (e.g., Decentralized Finance (DeFi) applications) along all identified areas of sustainability in digital sustainable cross-industry ecosystems as well as standardization, data security, data storage, integration, interoperability and scalability of blockchains.

An important driver is the connection of already existing and novel data sources such as open data initiatives from governments which allow new insights when connected with company and consumer related data. For example, the G20 Green Finance Study Group (GFSG) identified “Publicly Available Environmental Data” (PAED) and “Environmental Risk Assessments” (ERA) as barriers to innovative solutions. In addition, many approaches are based on historical data instead of real-time data (e.g., the use of machine learning for real-time forecasting of energy demand and supply by the use of weather data or the improved modelling of demand and supply of road traffic and public transportation systems by identifying consumers’ mobility patterns, (Rolnick et al., 2019)). An approach which aims at analyzing entirely new data sets focuses on atmosphere data as a global sensor (www.darpa.mil/news-events/2020-02-13), where the ionosphere can be analyzed regarding environmental events like tornadoes and tsunamis and their causes.

Research and Innovation Field 4	<p>(4.1) Novel Applications: Novel FinTech, InsurTech and blockchain applications for sustainable digital finance ecosystems</p> <p>(4.2) Novel Data and Integration: Novel ways of integration, standardization and scalability of FinTech, InsurTech and blockchains for sustainable digital finance ecosystems</p>
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4. A New Sustainable Digital Finance Innovation Platform

The very broad analysis of approaches in this paper based on academic literature and approaches from practice and the start-up community revealed valuable insights about the state of the art in the new discipline of “Sustainable Digital Finance”. This paper proposes a newly created research and innovation platform which is hosted by Stanford University (representing the “Silicon Valley”) and the University of Zurich (representing the “Crypto Valley”) and will allow the connection of the various stakeholders along the innovation value chain covering research and development, conversion and diffusion. This platform intends not to stop with research, but to develop start-ups in all relevant fields of Sustainable Digital Finance (see Figure 6):

- **Research and development:** The linkage of outside-in knowledge with expertise available in organizations provides an intensive powerful tool. The joint development of novel concepts from researchers together with various stakeholders is the key ingredient.
- **Conversion:** Very often research remains at the stage of (basic) research and is not transformed or “converted” into novel solutions which can be used in the real world. The platform shall therefore also build a bridge to applicable results. A dedicated accelerator program will help to launch innovative start-ups in this phase.
- **Diffusion:** The diffusion is the last step of distributing knowledge. This phase includes the publication of the concepts, events and networking with other relevant stakeholders.

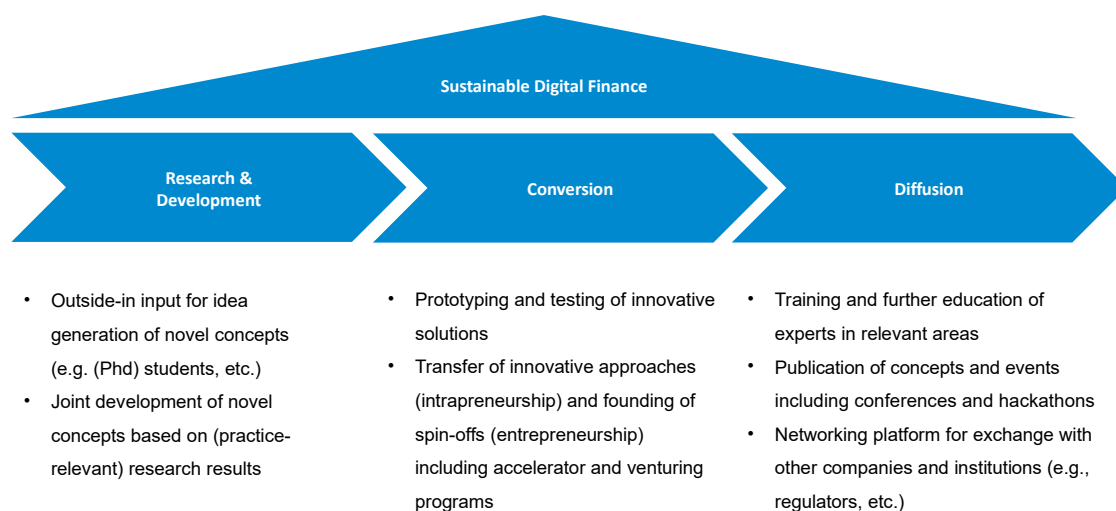


Figure 6. Innovation Value Chain for Sustainable Digital Finance

The launch of the Sustainable Digital Finance Innovation Platform requires it to be beneficial for all stakeholders, yet it asks for substantial investments from all of them. While a prediction of the future has proven difficult, joint efforts have often played out: Sustainability requires innovation to achieve progress and innovation requires collaboration to achieve progress. We believe in both!

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